SureTemp®

Model 767 Thermometer

Technical Manual

CE 0050

Welch Allyn

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WARRANTY

3-YEAR LIMITED WARRANTY ON NEW INSTRUMENTS: Instrumentation purchased new from Welch Allyn, Inc. (Welch Allyn) is warranted to be free from original defects in material and workmanship under normal use and service for a period of three years from the date of first shipment from Welch Allyn. This warranty shall be fulfilled by Welch Allyn or its authorized representative repairing or replacing at Diatek's discretion, any such defect, free of charge for parts and labor.

Welch Allyn should be notified via telephone of any defective product and the item should be immediately returned, securely packaged and postage prepaid to Welch Allyn. Loss or damage in shipment shall be at purchaser's risk.

Welch Allyn will not be responsible for loss associated with the use of any Welch Allyn product that (1) has had the serial number defaced, (2) has been repaired by anyone other than an authorized Welch Allyn Service Representative, (3) has been altered, or (4) has been used in a manner other than in accordance with instructions.

90 DAY LIMITED WARRANTY ON PROBES AND PROBE COVERS:

Welch Allyn warrants probe covers and probes to meet Welch Allyn's specifications for the Product at the time of purchase and to be free from original defects in material and workmanship under normal use and service for a period equal to 90 days from the date of first shipment of such Product to the customer by or on behalf of Distributor.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTY OR MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESSED OR IMPLIED. WELCH ALLYN WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

The information in this manual has been carefully reviewed and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Furthermore, this information does not convey to the purchaser of Welch Allyn devices any license under the patent rights to the manufacturer.

SPECIFICATIONS

Case Dimensions:	5.1 inches high x 4.1 inches wide x 4.0 inches deep.
Case Material:	ABS Plastic.
Weight:	1.0 lbs
Input:	Welch Allyn Thermistor Probe (Oral P/N 02767-000, Rectal P/N 02767-100).
Display range:	28.9^{o} C to 42.2^{o} C (84.0^{o} F to 108.0^{o} F).
Laboratory Accuracy:	± 0.2^{o} F in the Monitor mode and in a water bath per Welch Allyn SOP 90565-000.
Clinical Accuracy:	Meets the proposed ASTM clinical test criteria.
Push buttons:	Mode button
Probes:	Interchangeable Oral, Rectal
Power Source:	Model 767 Wall Transformer.
Display Type:	Liquid Crystal Display, 3½ digits plus special icons.
Operating temperature:	16^{o} C to 40^{o} C (60.8 ^{o} F-104^{o} F) @ 15% to 95% RH non-condensing per ASTM E1112-86.
Storage Temperature:	-20^{o} C to 50^{o} C (-4^{o} F-120^{o} F) @ 15% to 95% RH non-condensing per ASTM E1112-86.

OPERATIONAL CHARACTERISTICS

Introduction

The Welch Allyn 767 SureTemp is a wall mounted thermistor thermometer to be used for measuring patient temperatures ranging from 84 °F to 108 °F (28.9 °C to 42.2 °C). Oral and rectal probes utilize single-use disposable probe covers which limit cross-contamination. Oral and rectal temperatures are taken using Normal or Monitor operating modes. Axillary temperatures are taken with an oral probe with the unit operating in the Monitor mode. In the **Normal** mode, the thermometer's microprocessor "predicts" body temperature in about 4 seconds for oral temperatures and in about 15 seconds for rectal temperatures. The **Monitor** mode continuously displays the temperature of the probe which will reflect the patient's actual temperature in about 3 minutes and will continue for as long as the probe remains in place.

Basic System Description

The thermometer system consists of four main components: the external AC power supply, the thermometer instrument, the probe, and the probe cover.

The M767T Thermometer can use either a Welch Allyn Model 767 domestic (120V 60HZ) or international (230V 50Hz) Wall Transformer or a Welch Allyn Model 77305 AC Adapter for its external AC power supply. These power supplies are available from Welch Allyn.

The main instrument's operation is described below.

The Model 767T is easily connected to the Model 767 Wall Transformer. Two screws are used to secure the Model 767T to the Model 767 Wall Transformer. The use of a 9' long probe cord with a safety latch incorporated into its connector housing ensures that the Model 767T can be safely used with the Model 767 Wall Transformer without slipping out of its connector.

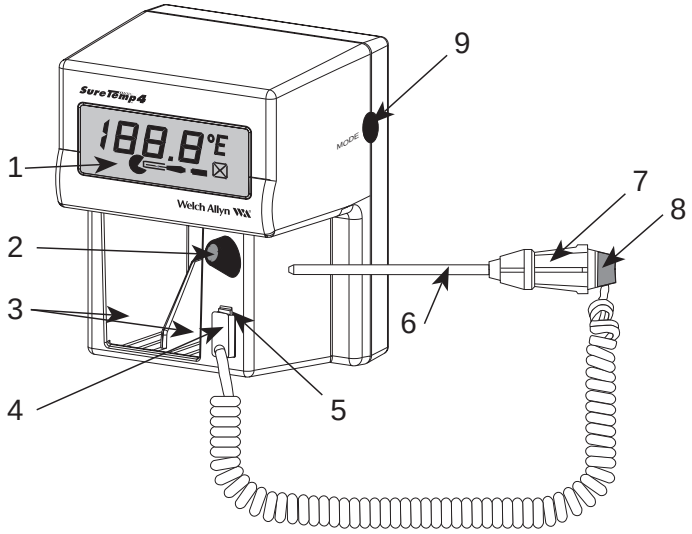
The Model 767T probe is similar in appearance to the probe for the M600, M670, and M675; but is incompatible with any of these instruments. M600, M670, and M675 probe are also incompatible with the Model 767T instrument.

Welch Allyn's 767T thermistor based probes can be identified by color combinations as follows:

Handle Color	Top Color	Connector Color/Type	Model #	Probe Type
Fog White	Blue	Fog White, Latching	M767T	Oral
Fog White	Red	Fog White, Latching	M767T	Rectal

The Model 767T instrument's connector receptacle configuration and size disallows insertion of any but Model 767T probes.

The probe covers are unchanged from previous models and are compatible for use with all of Welch Allyn's thermistor based thermometers.



1. Display
2. Probe storage channel
3. Dual probe cover storage well
4. Probe connector receptacle
5. Probe connector receptacle latch
6. Probe
7. Probe handle collar
8. Ejection button
9. Mode selection button

FIGURE 1 - THERMOMETER DIAGRAM

Safety & Warnings

⚠ CAUTION: DISCONNECT THE SYSTEM FROM THE MAINS SUPPLY BEFORE CONNECTING THE 767 SURETEMP 4 THERMOMETER.

⚠ USE THE 767 SURETEMP 4 WITH WELCH ALLYN 3.5V 767 SERIES WALL TRANSFORMER ONLY.

⚠ DO NOT USE IN THE PRESENCE OF FLAMMABLE ANESTHETICS.

Caution: Federal (USA) law restricts this device to sale by or on the order of a physician.

In order to obtain accurate and reliable temperature-taking results and ensure patient safety, it is important that this booklet be read thoroughly prior to using the instrument. If you have any technical or clinical questions concerning the thermometer's use and/or care, please contact our Customer Service Department at (800) 854-2904.

- Single-use disposable probe covers, available from Welch Allyn or Diatek, will limit patient cross-contamination. The use of any other probe cover or the failure to use a probe cover may produce temperature errors and will invalidate the instrument's warranty.
- Oral probes (blue ejection button) are to be used for taking oral and axillary temperatures only. Rectal probes (red ejection button) are to be used for taking rectal temperatures only. The use of the wrong probe will produce temperature errors.
- The thermometer case is not waterproof; do not drip fluids onto it.
- Do not use this instrument for any purpose other than that specified in this booklet. Doing so will invalidate the instrument's warranty.
- Do not use the thermometer if you notice any signs of damage to the probe or instrument. Contact our Customer Service Department for immediate assistance.

Setup

1. Install supplied Oral probe or optional Rectal probe by inserting the latching plug on the end of the coiled cord into plug receptacle on the unit. The plug snaps into place and cannot be removed without depressing the latch. (Figure 1).
2. Insert probe shaft completely into probe storage channel.
3. Turn on the 767 Wall Transformer.
4. CHr (blinks) and (steady) are displayed when an oral probe is installed. When displayed, the thermometer is characterizing the probe. The display will clear when complete. This process will take from 10 - 70 seconds.

   rEC°F is displayed when a rectal probe is installed.
5. Remove the probe from the storage channel.
6. Observe the LCD to see that all display segments appear followed by the display of the probe type OrL = Oral or rEC = Rectal. Replace probe in storage channel.
7. Insert two boxes of disposable probe covers (part number 05031) into the dual storage well.

Changing Probes

- Depress the latch and unplug the probe connector from the thermometer.
- Remove the probe from the storage channel.
- Repeat steps 1 through 6 in the SETUP section.

Normal Mode

Most temperatures are taken in the Normal (predictive) mode. The thermometer automatically resets to the Normal mode after the probe is returned to the storage channel.

Note: For Oral probes; if the instrument's display changes to the probe type display, **OrL°F**, before the probe cover is loaded, the display will change to**°F** (without **OrL**) briefly upon loading of the probe cover. The instrument is not ready for the probe to be inserted into the patient's mouth until the display returns to **OrL°F**.

The thermometer will switch to Monitor Mode automatically under the following conditions:

1. If the prediction algorithm has not been activated within 30 seconds of withdrawing the probe from the probe storage channel.
2. If the instrument determines that room temperature is above 33.9°C (93.0°F).

   The thermometer reads the probe temperature immediately upon removal of the probe's shaft from the storage channel. If the probe is extracted immediately after taking a temperature; it will not have had sufficient time to cool to room temperature. This will cause the instrument to detect a false room temperature higher than actual room temperature.

Monitor Mode

Monitor mode is generally used for long term temperature monitoring, taking axillary temperatures, or when difficult situations prevent accurate temperatures from being taken in the Normal mode.

When used correctly, the instrument will display the patient's temperature in about 4 seconds. The instrument will beep briefly to signal completion of the Normal mode temperature cycle.

If the probe's shaft is not inserted into the storage channel within 30 seconds of completion of a Normal mode temperature cycle, the instrument will shut off. Simply replace the probe's shaft into the storage channel to prepare for the next temperature.

Note: The instrument will shut off automatically if the probe temperature remains below 28.9°C (84.0°F) for more than 5 minutes.

Biotech Mode

Biotech mode provides the ability to query the following information:

1. Display test.
2. Software revision.
3. Internal temperature reference measurement to the nearest 1/100 of a degree Fahrenheit.

4. Probe temperature to the nearest 1/100 of a degree Fahrenheit (98.30 will be displayed as 830).

Biotech Mode is entered by the following steps:

Note: While in the Biotech mode, the leading digit and decimal point are suppressed in order for the instrument to display temperatures at higher resolution (i.e., 98.3 °F will be displayed as 830).

1. Ensure that a probe has been installed.
2. Depress and hold the Mode button for 7 seconds.
3. Observe that the instrument completes its display test. This is the same display test as initiated when power is first applied. Each segment of the display is individually lit. Following this, all segments are lit briefly.
4. The instrument will then momentarily display the software revision with the left half of the probe shaft icon and the probe cover icon (indicating Biotech Mode). The display should show “r X.X” where “X.X” is the revision number (i.e., r1.5). You will need to know the revision number when discussing operation with Welch Allyn customer support.
5. A temperature display of the internal-reference-resistor measurement comes next. This reading is generated by the instrument reading an internal, precision, fixed resistor as if it were a probe. If all of the A/D conversion electronics are functioning properly, this measurement will produce a reading between 678°C (36.78°C) and 689°C (36.89°C), or 820°F (98.20°F) and 840°F (98.40°F), inclusive. Momentarily depressing the Mode button will always toggle the reading between Celsius and Fahrenheit regardless of the mode.
6. A display of the probe tip temperature can now be obtained by withdrawing the probe from its holder. The display will be of the same form as the internal-reference-resistor measurement display (see above).

   Note: If the probe is not removed from the probe holder within 1 minute, the unit will exit from the Biotech Mode.
7. To exit Biotech Mode at any time, put the probe back into its holder. If the probe was never removed from its holder, pull it out from its holder and then return it to its holder.

If you cannot enter the Biotech mode, refer to the **Biotech Mode Problems** section of the **Troubleshooting** section.

PREVENTATIVE MAINTENANCE

The following suggested preventative maintenance is recommended to maximize uninterrupted service on the Model 767 SureTemp 4 Thermometer

Units which are in service on a regular basis should have the following preventative maintenance performed every 6 months:

1. Visually inspect the thermometer for physical damage which might cause future product failure.
2. Clean the unit per instructions in your Directions for Use manual supplied with the thermometer and/or per the instructions below.

3. Perform the power up display test, startup display test and Model 9600 Calibration Testing procedure found in the Model 9600 Operation Manual. Perform calibration adjustment if determined necessary by following the procedure in this manual.

Cleaning and Sterilization

Routine Cleaning

Refer to the Directions for Use for routine cleaning

ETO Gas Sterilization Procedure

When no other form of decontamination such as a germicidal wipe is acceptable, a low temperature, (not to exceed 48.9°C (120°F)) ETO gas sterilization cycle may be used. Refer to your institution's standard operating procedure for the length of the cycle.

This type of sterilization may cause some hazing of glossy plastic surfaces and should be used only when absolutely necessary.

1. Disconnect the Model 767 Thermometer from the power supply.
2. Ensure that the probe is removed from its storage channel and disconnected from the instrument.
3. Remove any probe covers from the probe cover storage well
4. Wrap the thermometer in a standard sterilization type packaging such as a Baxter Tower Dualpeel Sterilization Pouch.
5. ETO gas sterilize at a temperature not to exceed 48.9°C (120°F) and aerate.
6. Remove the sterilization packaging.
7. Before applying power, allow the probe and instrument to stabilize to room temperature for *at least one hour.*
8. Verify proper calibration of the thermometer and probe using the Welch Allyn Model 9600 Calibration Tester.

CALIBRATION TESTING

Calibration Key Procedure

Unplug the probe from the thermometer. Insert the Calibration Key into the probe connector receptacle on the thermometer. Remove the probe shaft from the probe storage channel to initiate a temperature taking cycle. Wait for the display test and then observe the display. The display must read between 97.1°F and 97.5°F inclusive for the calibration of the instrument to be correct. Remove the Calibration Key and reinstall the probe connector plug. Then install the probe into the probe storage channel. (This will initiate a probe characterization cycle.)

Note: This Cal Key test does not test the calibration of the probe. To do so requires the use of the Welch Allyn Model 9600 Calibration Tester.

If the reading from the Cal Key is not within the specified range or you are having other problems with the use of the Cal Key, refer to the **Cal Key Problems** section of the **Troubleshooting** section.

M9600 Procedure

The M9600 Calibration Tester provides a convenient means of testing the entire thermometer system (instrument and probe). The 9600 must be warmed up and stable at one of the two available temperature settings. The thermistor based instrument under test must be in Monitor mode and no probe cover loaded. The probe is inserted into the small hole in the dry heat well of the 9600 and allowed to settle to the final temperature. The reading on the thermometer must be within the range specified on the 9600. Refer to the M9600 Operation Manual for complete instructions.

Note: All Welch Allyn thermometers (thermistor and infrared ear thermometers can be checked in the M9600.)

If you are having problems with the use of the M9600, refer to the Troubleshooting section in the M9600 Operation Manual.

THEORY OF OPERATION

Technical Overview

The heart of the Model 767 Thermometer is comprised of two custom integrated circuits, a standard microcontroller, and an LCD driver which provide most of the microprocessor and analog circuit functions. All control functions are governed by the Motorola MC68HC11D0 microcontroller (U1) and a memory/IO chip (U2). All analog interfacing to the microprocessor, probe, horn, self-calibration circuit, and backlight is provided by U4, and the LCD is controlled by U5.

Probe resistance measurements are made by measuring pulse widths which are generated by sequentially switching in two calibration resistors and the probe thermistor, one at a time. These pulse widths are measured by the microcontroller which calculates the probe resistance. The actual probe temperature is then calculated from the probe resistance.

Probe Enhancements

The Model 767 Thermometer has the capability to detect probe type - Oral vs. Rectal. This allows the oral temperatures to be as fast as possible (4 seconds) by using different operating modes based on probe type. Rectal probes give a Normal mode temperature in about 15 seconds. Probe type recognition also allows the use of minor differences in prediction parameters tailored to the temperature taking site to help increase speed over most previous products.

The probe type is configured for thermometer recognition by connecting the appropriate combination of probe connector contacts to ground within the probe assembly connector.

In addition to the probe type enhancements, Model 767 Thermometer probes have been improved for thermal time constant (speed of response).

Model 767 Thermometer Oral probes incorporate a warming resistor in the tip to pre-warm the probe before placement in the mouth thus speeding response even further.

Probe Switch

The probe switch (S2) is activated by the probe shaft when the probe is installed or removed from its storage channel. Placing the probe into the channel, pulls U1-29 high via R27. When the probe is withdrawn, this line is pulled low. This signal is also routed to test connector J3A, pin 7, to allow automated testing of this function during factory test. R27 allows this line to be pulled high or low at J3A during factory test regardless of the actual switch position.

HINT/CAUTION: For the technician, J3A serves as a convenient set of “test points” to monitor proper operation of all user switch functions, BUT BE CAREFUL WITH STATIC DISCHARGE! J3A TIES DIRECTLY TO CMOS PROCESSOR INPUTS WHICH ARE EASILY DAMAGED BY STATIC DISCHARGE. FOLLOW PROPER HANDLING TECHNIQUES.

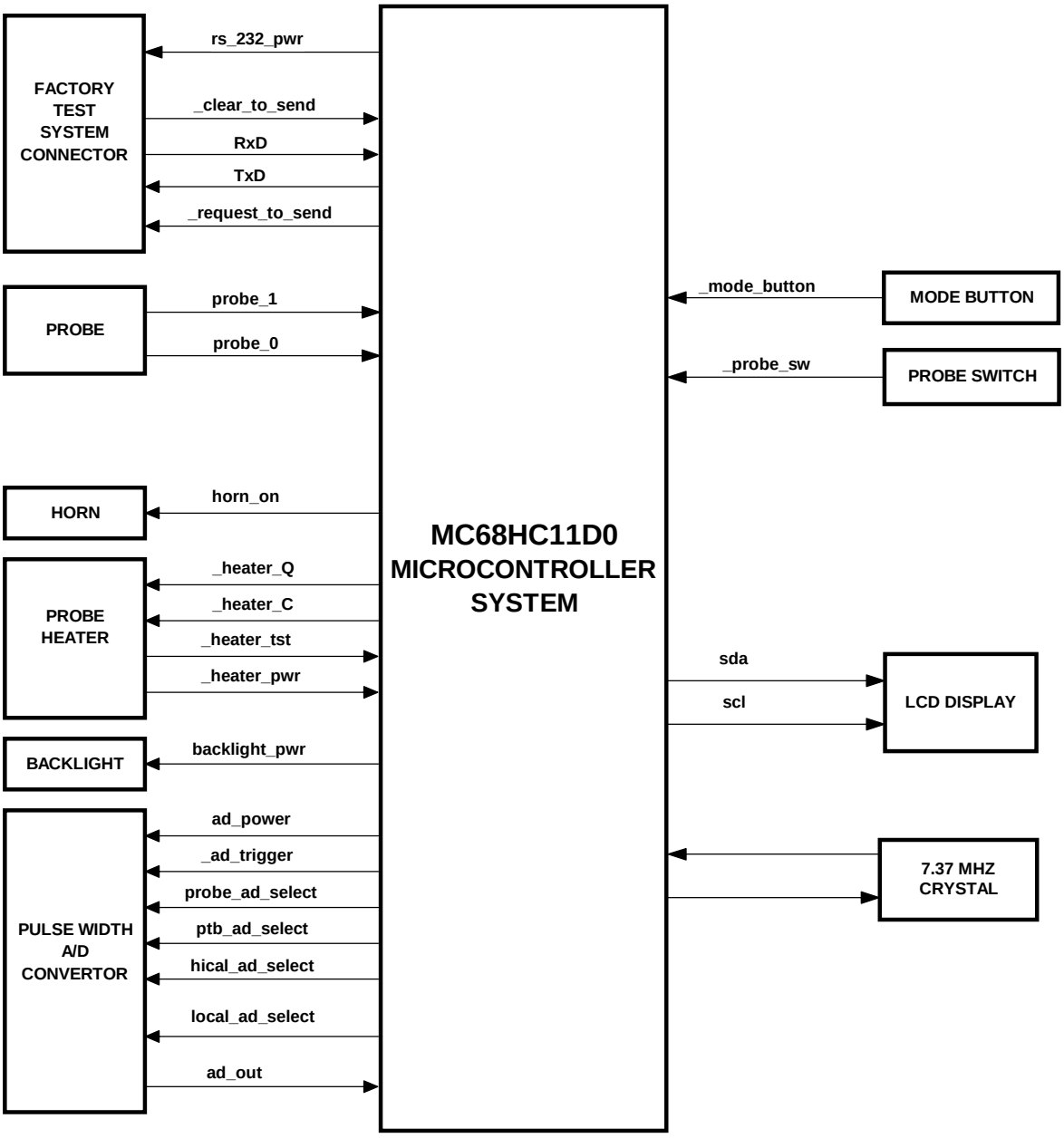


FIGURE 2 - SYSTEM BLOCK DIAGRAM

Monitor Mode

The Monitor mode is selected manually by the Mode button (S1) on the right side of the instrument. This button, when pressed, ties U1-30 low. When this line (*DMODE) is held low for more than two seconds with the probe's shaft withdrawn from its holder, the thermometer enters Monitor mode. *DMODE is routed to the test connector (J3A-10) to allow automated testing of this function during factory test

The actual probe temperature, as determined by the A/D conversion electronics, appears directly on the liquid crystal display which is driven by the LCD driver (U5). See the **Temperature Measurement and Display** section for a description of the A/D operation.

The displayed temperature range (for any mode) is limited to 28.9°C to 42.2°C (84.0°F to 108.0°F).

Normal Mode

The Oral probe is pre-warmed using a pulse width modulation (PWM) controller to 33.9°C (93°F) upon extraction from the storage channel. When the probe is first extracted and colder than 33.9°C, the pulse widths are at a maximum percentage ON vs. OFF to warm the probe quickly. When the probe reaches 33.9°C, the pulse widths narrow to a duty cycle just enough to maintain temperature. When the probe is placed in the mouth, the heat supplied by the mouth makes the pulse widths reduce to zero. This reduction to zero (and the probe being at least up to 33.1°C) triggers the start of the prediction algorithm.

The shape of the rising temperature curve is monitored and the best fit to a curve is found. When the curve fit is stable, the final predicted temperature is displayed.

If the prediction criteria explained above are not met within 15 seconds of starting the prediction process, it will automatically switch to Monitor mode.

If the ambient temperature is above 33.9°C (93.0°F) the unit will automatically switch to Monitor mode.

Rectal probes are not prewarmed. The shape of the rising temperature curve is monitored and a continuously computed correction factor is added to the actual probe temperature. The temperature cycle is terminated and the temperature is displayed when the predicted temperature remains stable.

If the thermometer does not detect a rise of two degrees above ambient within 30 seconds of removing the probe from its holder, it will automatically switch to Monitor mode.

Power Supply

Power is drawn from an 8VAC power supply. This AC voltage is converted to DC by a full wave bridge rectifier (D1, D2, D7, and D8), regulated by a low dropout 5 volt regulator (U3), and filtered by capacitors (C3, C4, C5, C16, and C17). The regulated voltage will range from about 4.75 volts to 5.25 volts DC. This +5VDC (Vdd) is further filtered to create an analog 5 volt branch (+5VA).

Microcontroller I/O Assignments

The following table depicts the input/output assignments for the microcontroller, with “active low” signals prefixed with an underscore (refer to schematic and block diagram):

MC68HC11D0 Input/Output Assignments			
Signal Name	Port	In/Out	Pin Number
R/_W	PD7, R/_W	Out	12
AS	PD6, AS	Out	13
_wake_up	_IRQ	In	15
RxD	PD0, RxD	In	16
TxD	PD1, TxD	Out	17
MISO	PD2, MISO	In	18
sda	PD3, MOSI	Out	19
scl	PD4, SCK	Out	20
backlight_pwr	PD5	Out	21
_heater_C	PA7	Out	23
_heater_Q	PA6	Out	24
_request_to_send	PA5	Out	25
horn_on	PA4	Out	26
_clear_to_send	PA3	In	27
ad_out	PA2, IC1	In	28
_probe_sw	PA1	In	29
_mode_button	PA0	In	30

Memory/IO Input/Output Assignments

The following table depicts the input/output assignments for the PSD311L peripheral, with “active low” signals prefixed with an underscore (refer to attached schematic and block diagram):

PSD311L Peripheral Input/Output Assignments			
Signal Name	Port	In/Out	Pin Number
probe_1	PB7	In	4
probe_0	PB6	In	5
not used	PB5	Out	6
rs_232_pwr	PB4	Out	7
probe_out	PB3	Out	8
probe_in	PB2	Out	9
_heater_tst	PB1	In	10
_heater_pwr	PB0	In	11
_ad_trigger	PA7	Out	14
ad_power	PA6	Out	15
probe_ad_select	PA5	Out	16
ptb_ad_select	PA4	Out	17
hical_ad_select	PA3	Out	18
local_ad_select	PA2	Out	19
_batt_ad_select	PA1	Out	20
not used	PA0	Out	21
not used	PC0	Out	40
not used	PC1	Out	41
not used	PC2	Out	42

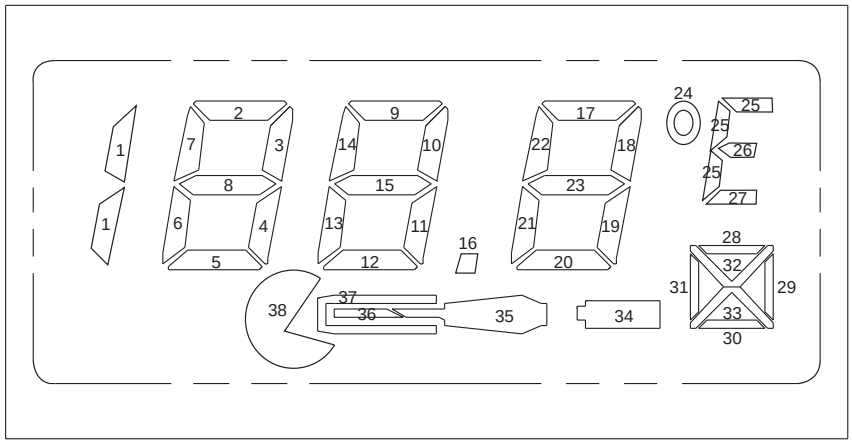
NOTE: All unused I/O pins are set to output.

IIC Interface to LCD Display Driver

The display driver utilizes an IIC serial interface. Each write to the display (signals **sda** and **scl**) must begin with the following four command bytes followed by up to eight data bytes: 70H (device type), e0H (device select), c8H (device mode), 18H through 26H (LCD driver RAM start address). **MISO** is externally tied to **sda** to allow a read of the IIC acknowledge as required.

With all LCD segments activated, the 767T display appears as shown in **Error! Reference source not found.**. **Error! Reference source not found.** also includes the interface between the LCD driver ram addresses and the corresponding LCD segment, which provide visual enunciators to display status and/or alarm indications as follows:

- "Instrument Malfunction" icon consists of a square box with an X within it, (segments 28-33), which indicates that the unit has detected an internal malfunction or the unit is unable to make an accurate determination due to a failure of the unit's internal circuitry;
- "Up - Down Arrows" indicate that the patient temperature is above 108^{o} F (42.2 ^{o} C), or below 84^{o} F (28.9 ^{o} C) respectively. The up arrow is formed by displaying the bottom half of the X, (segment 30), plus the bottom side of the square box; (segment 33), the down arrow is formed by displaying the upper half of the X, (segment 32), plus the top side of the square box; (segment 28),
- "Broken Probe" icon consists of a probe silhouette where the distal half of the probe shaft, (segment 36), and the probe body, (segment 35) are flashed. This icon is displayed whenever the unit is active and a malfunction within the temperature probe has been detected;
- "Probe Position" icon consists of the "PacMan" open mouth silhouette, (segment 38), and the probe silhouette, (segments 35, and 36), lit to inform the user of improper probe placement into the mouth;
- "Monitor Mode" icon consists of a capital "M" formed out of the left and right sides of the square box, (segments 31 and 29), and the upper half of the X, (segment 32); it is displayed whenever the unit is active and in Monitor Mode;
- "Fahrenheit/Celsius" icon is indicated by displaying either a "F", (segments 25 and 26), or a "C", (segments 25 and 27), respectively to indicate the units of the displayed temperature.
- Bio Tech mode icon consists of the distal half of the probe shaft, (segment 36), and the probe cover, (segment 37). It is displayed whenever the unit is in Bio Tech Mode.



DRIVER ADDRESS	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
24 - 25	-	-	-	-	-	-	-	34
26 - 27	-	-	-	-	-	-	-	1
28 - 29	7	8	6	5	2	3	4	-
30 - 31	14	15	13	12	9	10	11	16
32 - 33	22	23	21	20	17	18	19	-
34 - 35	-	-	-	-	24	25	27	26
36 - 37	30	33	-	29	31	32	-	28
38 - 39	-	-	-	-	35	36	37	38

FIGURE 3 - LCD DISPLAY

Reset/Self Tests

Upon power-up, the microcontroller and memory/IO chips (U1 and U2) receive a power-up reset signal from the components associated with the reset line (U1-14 and U2-3). During power dropout, the voltage regulator, U3, generates a reset signal. When *RST goes high, C7 is charged slowly through R13 providing a slow rise reset to the microcontroller and memory/IO chips.

The delay between power-up and the beginning of *RST rise is determined by C1.

When the reset signal is complete, the microcontroller and memory/IO chips launch a series of self checks which include RAM test, ROM test, EEPROM test, instruction set test, self calibration tests (PTB test, hi cal, low cal), probe warmer circuitry tests, probe test, and ambient temperature test. Any failures here will cause a specific error code to be displayed to assist debugging.

Microprocessor Clock

The clock for the processor is generated by X1. This is a single 3 pin ceramic resonator with internal capacitors running at 7.3828 MHz. The microcontroller, U1, drives this component into oscillation by incorporating an internal inverter.

Temperature Measurement and Display

The thermometer uses probes which incorporate negative temperature coefficient thermistors. When the temperature of the probe is increased, its electrical resistance decreases. Earlier products (M600, M650) use “10K” thermistors which means that, at room temperature (25°C), their value is approximately 10 Kohms. Model 767 Thermometer probes use “20K” thermistors so they are approximately 20 Kohms at room temperature. At 37°C (patient temperatures) they are near 12 Kohms. The change in resistance is nonlinear with temperature and an equation describing this curve is programmed into the thermometer.

The thermometer contains three high precision calibration resistors (0.1% tolerance) R20, R21 and R23. Their values are programmed into the instrument so that A/D conversions from these can be done to “calibrate” the electronics. This allows results from the unknown probe resistance to be compared to the known resistance’s. These three resistors are referred to as “hi cal”, “low cal” and “PTB” resistors. They are equivalent to temperatures in that if the probe were at a high temperature 41.6°C (106.8°F), its resistance would equal the hi cal resistor value. Similarly if the probe were at a low temperature 33.8°C (92.9°F) its resistance would equal the low cal resistor value. The PTB resistor is in the middle of the range and equivalent to 36.8°C (98.3°F). Use of these resistors in the A/D process allows the probe resistance readings to be “ratioed” against known resistance readings and thus “absolute” readings, which can be affected by drift in the electronics due to aging and temperature, are eliminated.

The actual A/D conversion consists of converting resistance to a timed pulse width. The components involved are C6 (the timing capacitor), Q7 (the constant current transistor), any one of R20, R21, R23 or the actual probe resistance, and the associated FET transistors Q3, Q5, Q6, or Q8.

Due to U4 design, on power up R24 and R26 bootstrap U4 to begin the charge of C6. Once a small voltage is developed on C6, U4 takes over and maintains C6 at 2.4 volts via pin 7 of U4. When an A/D conversion is to start, prior to the trigger from the processor, it turns on one of the four FETs. This establishes a constant current through the associated resistor. The current flowing is supplied from U4 pin 7 while maintaining its voltage at 2.4 volts. Throughout the A/D process, U4 pin 4 is held at 1.2 volts. This means that while current is flowing through Q7, its emitter sits at 0.6 volts. Since this is a constant voltage, the current through the selected resistor and FET is also constant. The next event is to trigger the start of the pulse measurement which occurs via processor control into U4 pin 5. This makes U4 pin seven go to high impedance ending its supply of current for the selected resistor. Therefore current must now be supplied by C6. Since it is still a constant current situation, C6 discharges linearly with time. Its voltage is monitored by an internal comparator in U1 and when it drops to 1.2 volts the A/D OUT line (U4 pin 2) goes active stopping the timer in the processor. The constant current value is inversely proportional to the resistance value selected so that small resistance values produce high currents and therefore fast discharges. Since small resistance’s are related to high temperatures, short pulse widths are also related to high temperatures. L3 is in series with the discharge current but constitutes a very small constant DC resistance so it has no effect on results. Its only purpose is for RFI suppression. C9, C10, C11, and C12 are also only for RFI, and ESD purposes.

In Monitor mode a calibration cycle, where each of the fixed resistors is measured by the A/D function, is performed once every second. In Normal mode a calibration cycle is performed once at the beginning of the temperature prediction process.

A/D Power Control

When A/D conversions are not needed, power is saved by shutting down U4 via the A/DPWR line on U2 pin 15. R22 serves as a current limiting resistor and establishes the low power draw for U4's internal current sources.

This A/DPWR line is also routed to R9 and R12 for probe detection. This provides a power saving function so supply current is not drawn through these resistors when probe detection is complete.

Additionally, A/DPWR is routed to U5-5 to supply the LCD driver with power. This provides a power saving function in that power is not drawn by the LDC driver nor LCD when not needed.

Probe Detection

Upon power-on reset or when a new probe is first installed, the thermometer performs a probe initialization process. Probe type is first detected and then if it is an Oral probe, its warming characteristics are determined. No Rectal probes are warmed, so warming characteristics are not tested in either instrument on these probes.

When the probe connector is removed, U2 pins 4 and 5 are pulled high by R9 and R12, and a "no probe" logic is detected. Upon determining that the probe has been removed, a software flag is set in RAM indicating the probe has been removed. (RAM contents are not lost when the processor "goes to sleep.") With no probe installed, the unit goes to sleep and turns off the clock and the A/D power line to save battery power.

Probe connector installation does not wake the instrument up. When the probe shaft is stowed, the probe switch places voltage on U1 pin 29 via R27. This alerts the microcontroller which then reads the RAM flag and sees that the probe logic lines are indicating a probe is connected. This situation triggers a probe characterization routine as described in the Probe Warming section.

The probe type is determined by the probe logic lines at J1-C and F. Oral probes pull both lines low. Rectal probes pull only J1-C low.

Probe Warming

Probe characteristics vary somewhat due to normal production process variations and it is desirable to warm the probe as efficiently as possible from a time--to--ready standpoint and from a temperature stability standpoint when the probe is up to temperature.

The probe warming process is a closed loop feedback control system incorporating PWM (pulse width modulation) control. To establish proper control parameters, the probe under control must be characterized.

The probe temperature is read once every 200 mS until the temperature is found to be not changing.

Once a stable temperature is determined a 200 mS test pulse of power is applied to the probe via the warming circuitry. The probe temperature change resulting from this pulse is used to determine parameters needed for the PWM algorithm. This completes the probe characterization process.

The warming circuitry consists of Q2, Q4, Q10, R8, R15, R16, R18, R25, R28, C14, C15, C202, D6, L1 and the resistance in the probe connected to J1-B and J1-E. Power is applied to the probe connection only when both Q2 and Q9 are turned on. When this occurs, both feedback lines to the processor (U2 pins 10 and 11) are pulled high indicating proper operation. A fail safe hardware shut off circuit is incorporated consisting of C14, D6, Q10 and R25. This circuit will shut off power to the probe if the software fails to refresh this circuit. This prevents overheating due to any software errors leaving the warmer circuit on continuously.

At the start of a warming pulse, the processor drives both warmer control lines (U1-23 and U1-24) low. This turns on all three transistors Q2, Q9 and Q10. Q10 is turned on because the voltage across capacitor C14 cannot change instantly. Its positive side goes low when its negative side is pulled low by the processor. Since Q9 E and B are pulled near the positive rail and Q8 B and E are pulled near the negative rail, the base current from Q9 flows through R28 and mostly into Q10, but some current flows through R25 to satisfy the diode drop across Q10 E to B. This current and Q10 base current flow into C14 charging it. As it charges, the voltage rise eventually shuts off Q9.

This hardware shut off is only allowed to progress to completion during factory test and each time an Oral probe is installed as part of the instrument self test process. The thermometer checks that the hardware shut off has occurred within one second of turn on.

Normal probe warming is controlled by the software and if the probe is well below the control temperature of 33.9°C (93°F) the pulse widths are at a maximum. Every 100 mS the hardware shutoff circuit is refreshed by the processor driving its pin 54 high briefly. This momentarily shuts off power to the probe while discharging C14 into the positive supply through D6.

Once the probe has been brought near 33.9°C (93°F), the pulse widths are reduced to maintain this temperature. This is when the display switches from the all segments display test to “OrL” indicating that the unit is ready for placement in the mouth.

R8 and R18 in combination with R16 serve as pull down resistors ensuring that the processor feedback lines (U2 pins 10 and 11) go low immediately upon warmer component shut off. L1, and C15, and C202 serve as RFI suppression components.

Liquid Crystal Display

The LCD has 7 backplane lines (DS1 pins 1-7) and 12 segment lines (DS1 pins 8-19). The LCD fluid thresholds require a regulated set of voltages at 1.2, 2.4, and 3.6 volts. These voltages are set by the voltage that appears on U5-12 (0VDC) and are supplied to the LCD by the display driver (U5

The LCD glass is electrically tied to the display PCB via two elastomeric connectors sandwiched and compressed between the glass and the PCB by the 8 display retaining screws.

Backlight (Optional)

The backlight is an Electroluminescent style flat panel lamp residing directly under the LCD.

An oscillator is required to convert battery DC voltage to an AC voltage of about 80 volts and 300 Hz.

Whenever anything is being displayed, the microcontroller outputs a high to U4-12. U4 then outputs a low at pin 13, which is sent out to the backlight oscillator on the Display PCA via J2B-5. Vdd is also supplied to the oscillator via J2B-1. The oscillator consists of Q101, Q102, C102, R106, R107, D101, T1, and the lamp itself (DS2). R14 acts as a pull up to return this line high when not in use

Horn

The horn is activated at the start of a temperature taking cycle, at the end of a Normal mode temperature cycle, and for various error conditions.

A short duration high pitch single beep is indicative of normal operation. A short duration double beep is used to indicate errors.

The horn is a piezoelectric ceramic resonator driven by a processor square wave buffered through U4. The horn control signal comes from U1-26 and enters U4-3 where it is buffered and inverted and sent out on pin 1 directly to the horn LS1. R5 is used to limit the current applied to U4-3.

F/C Switching

When momentarily (less than 2 seconds) depressing the Mode button (S1), U1-30 goes low. The microcontroller then toggles the display from F to C or C to F. This line is also run to the test connector J3A-10 to allow automated testing of this function during factory test.

ERROR CODES

Error codes fall into three categories. Transitory, Recoverable and Non-Recoverable.

Transitory errors are generated by external events and are not errors generated by the thermometer. They do require that temperature measuring be inhibited until the error is cleared. There is no limit to the number of times a transitory error can occur. All probe problems are considered by the thermometer to be external events and are therefore classified as transitory.

Recoverable errors are generated from internal test failures which are non-catastrophic and require that temperature measuring be inhibited until the error is cleared. A recoverable error will be promoted to a non-recoverable error if it occurs 4 times sequentially. After displaying the error code and any appropriate icon, the instrument will reset itself and attempt to resume normal operation. After the fourth attempt to clear itself, the error becomes non-recoverable.

Non-recoverable errors are generated from internal test failures that are catastrophic (or from promoted recoverable errors). The error code and any appropriate icon will be displayed along with the “[X]” Instrument Malfunction icon.

The only way to continue at this point is to reset the electronics by cycling power.

NOTE: The error codes E1.0, E2.1, E2.3, E3.0, and E4.1 can sometimes be caused by a faulty probe. It is advisable to remove probe completely from instrument and check functionality as described in the Setup section before assuming an instrument problem instead of a probe problem. If another probe is available, this can prove useful in tracking down the source of the problem.

Error Code Table - Software Version R1.7 and above

NUMBER	ERROR TYPE	DESCRIPTION
		System Hardware/Software Errors
E0.1	NON-RECOVER	Internal RAM read/write test failed
E0.2	NON-RECOVER	Internal ROM check sum failed
E0.3	NON-RECOVER	CPU instruction error
E0.9	NON-RECOVER	Fatal Software Errors
		System Transitory Errors
E1.0	TRANSITORY	Outside ambient operating temperature range
C1.1	TRANSITORY	Probe characterization stability time out
E1.2	TRANSITORY	Probe broken or missing
E1.3	TRANSITORY	Transmit buffer overflow (transmit only, no display)
		A/D Converter Errors
E2.0	RECOVERABLE	Low cal. resistor pulse width error
E2.1	RECOVERABLE	Hi cal. resistor pulse width error
E2.2	RECOVERABLE	PTB resistor pulse width error
E2.3	RECOVERABLE	Probe pulse width error
		System Functional Errors
E3.0	RECOVERABLE	PTB test error
		Math Errors
E4.0	RECOVERABLE	Log of zero is undefined
		Heater and Probe Errors
E5.0	RECOVERABLE	Heater fail safe time out error
E5.1	RECOVERABLE	Heater circuit failure
E5.2	RECOVERABLE	Heater overheated
E5.3	RECOVERABLE	Heater watch dog time out
E5.4	RECOVERABLE	StartHeater initial pulse too large

Error Code Table - Software Version R1.6 and below

NUMBER	ERROR TYPE	DESCRIPTION
		System Hardware/Software Errors
E0.1	NON-RECOVER	Internal RAM read/write test failed
E0.2	NON-RECOVER	Internal ROM check sum failed
E0.3	NON-RECOVER	CPU instruction error
E0.9	NON-RECOVER	Fatal Software Errors
		System Transitory Errors
E1.0	TRANSITORY	Outside ambient operating temperature range
C1.1	TRANSITORY	Probe characterization stability time out
E1.2	TRANSITORY	Probe broken or missing
E1.3	TRANSITORY	Transmit buffer overflow (transmit only, no display)

Error Code Table - Software Version R1.6 and below (continued)

		A/D Converter Errors
E2.0	RECOVERABLE	Low cal. resistor pulse width error
E2.1	RECOVERABLE	Hi cal. resistor pulse width error
E2.2	RECOVERABLE	PTB resistor pulse width error
E2.3	RECOVERABLE	Probe pulse width error
		System Functional Errors
E3.0	RECOVERABLE	PTB test error
		Math Errors
E4.0	RECOVERABLE	Log of zero is undefined
		Heater and Probe Errors
E5.0	RECOVERABLE	Q heater transistor failure
E5.1	RECOVERABLE	C heater transistor failure
E5.2	RECOVERABLE	Heater fail safe time out error
E5.3	RECOVERABLE	Heater circuit failure
E5.4	RECOVERABLE	Heater overheated
E5.5	RECOVERABLE	Heater watch dog time out
E5.6	RECOVERABLE	StartHeater initial pulse too large

TROUBLESHOOTING

All thermometer operational parameters can be tested for proper operation without the unit being taken apart and without the need for any tools. Refer to the **Operational Characteristics** section and in particular to the **Setup** and **Biotech Mode** sections for guidance on preliminary checks.

If the trouble seems to be calibration related, refer to the **Calibration Testing** section.

If these sections do not prove useful in resolving the problem and you are sure that the instrument is not performing properly, the following sections should guide you through the debugging process, given the proper tools and equipment.

Equipment Required

Most operations can be performed with standard tools and meters. A 4” long Torx, T-8, driver is needed for most screws. A #1 Phillips screwdriver is needed for the probe switch screws.

A standard lab 3.5 digit digital multi-meter (DMM) will provide sufficient accuracy for a host of tests. A needle tipped pair of probes is recommended.

For particularly difficult tasks, a digital storage oscilloscope is sometimes the only way to analyze high speed signals, but is not generally required.

Standard electronics tools and supplies for small surface mounted and through hole component rework will be needed to perform any electronics repairs. Some surface mounted components are extremely small and present a challenge for rework by hand. A light touch, tweezers, sharp soldering iron tip and low heat (#7 tip) is recommended.

A Model 767 Wall Transformer is recommended for use as a power supply. Power and ground are available at J5-C and J5-D, respectively.

Terminology

Many standard abbreviations are used in this section (and elsewhere):

PCB	printed circuit board (the board itself)	LCD PCB	PCB holding the display assembly
PCA	printed circuit assembly (the board with all its components)	DMM	Digital Multi-Meter
Main PCB	large PCB holding the microprocessor	O-Scope	Oscilloscope
LCD	Liquid Crystal Display		

Component Reference Designators:

C	capacitor	Q	transistor
D	diode	R	resistor
E	test point	S	switch
J	connector jack	T	transformer
L	inductor	U	integrated circuit
P	connector plug	X	crystal, resonator

Troubleshooting Table

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
No operation	No power to unit	Make sure its power supply is plugged in and turned on. Make sure the power supply is providing between 5.9 and 10 Volts AC. Make sure the power contacts are making contact with the power supply.
	Short circuit.	The resistance at the power input contacts (J5-A and J5-B) should be at least 3MΩ. If it is less than this, check the power circuit for shorts. The resistance across the 5VDC test points (J5-C and J5-D) should be at least 20kΩ. If it is less than this, desolder the display electronics and check it again. If the resistance goes up, suspect a short on the display board. If the resistance did not go up upon desoldering the display board, check everything but the power electronics on the main board for shorts.
	Power circuit component malfunction	With power turned on, measure 5.0 VDC +\-5% across J5-C and J5-D (Gnd). If too low, lift J3-3 and check voltage between here and J5-D. If still too low, suspect U3. Check for a DC voltage of about 12 VDC at U3-1. If this is below 5.5VDC or is very unstable, suspect the filter capacitors (C1, C3, and C18 for low voltage), or rectifier diodes (D1, D2, D7, and D8 for unstable voltage).
	Failed component.	Check oscillator at U1-44 for 7.38 MHz sine wave. If not present, suspect X1, R1, or U1.
Display problems	LCD PCB loose.	Check that all 8 Torx screws holding the Display PCA to the Display housing are tight.
	Dirty, or crooked elastomeric LCD conductor (zebra) strips. Crooked zebra strip	Remove Display PCA by opening the case and unscrewing the 8 Torx screws on the Display PCA. Clean LCD elastomeric strips, LCD glass contacts, and PCB contacts with lint proof cloth dampened with alcohol. Check that the EL panel is not overlapping the black, Carbon ink covered zebra pads on the display PCB.
	Broken/shorted flex strip cable.	Check continuity of all 6 lines. Assure continuity with flexing of strip. Check for shorts between adjacent lines at both ends.

Troubleshooting Table (continued)

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
Display problems (continued)	Failed component in LCD driver circuit.	Check that data and clock signals on U5-1 and U5-2 are toggling between 0 and 5 volts immediately after power up or after pressing and releasing the Mode button.
	Cracked LCD.	Inspect LCD for hairline cracks especially in corners.
	Short circuit or open LCD lines.	Check continuity from LCD driver (U5) through to LCD pads. Check for shorts between adjacent U5 pins. Check for continuity from U1-19 and U1-20 to U5-1 and U5-2, respectively.
	Microprocessor failure (U1).	Check for improper soldering of pins, crystal operation on O-scope, proper reset.
	Memory/IO chip failure (U2)	Check for improper soldering of pins, crystal operation on O-scope, proper reset.
Dark blotches near the bottom of the display	Moisture between display window and LCD glass. Display screws too tight.	Remove, clean, and reassemble the LCD. Tighten screws starting from the upper right tooling hole (looking in the back of the display housing, and continuing counterclockwise.
No beeper sound	Broken horn wire	Inspect horn wires for proper soldering
	Defective horn	Replace horn
	Broken connection	Check continuity from U1-26 to U4 3. From U4-1 to red horn wire. From U4-14 to black horn wire. From U4-3 to blue wire and R5. From R5 to U1-26.
	Defective U4	Replace U4.
	Defective U1	Check for a logic high on U1-26 when horn should be on. If not, replace U1.

Troubleshooting Table (continued)

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
No Backlight (Backlight is an Option)	Broken trace.	Check U1-21 and U4-12 for proper signal level (+5V when LCD is on. U4-13 and the cathode of D101 should be low when the LCD is on. With backlight off, all of the oscillator parts (Q101, Q102, R106, R107, C102 and T1(primary) should be at +5VDC.
	Defective Component	Check U1-21 and U4-12 for proper signal level (+5V when LCD is on). U4-13 and the cathode of D101 should be low when the LCD is on. With backlight off, all of the oscillator parts (Q101, Q102, R106, R107, C102 and T1(primary) should be at +5VDC.
Recalled temperature incorrect.	Power cycled.	On power-up, the last stored temperature is replaced with 98.6^{o}F.
F/C switching problems	Defective Mode switch	Check J3A-10 for proper switch function. Line should go low only while Mode button is depressed.
	Broken trace	Check U1-30 for proper switch function.
Probe: Wrong type displayed.	Missing A/D power to R9 and/or R12	With no probe installed, check that probe connector pins J1-C and F are both pulled high when any function is active (recall)
	Incorrect wiring of probe	Oral probes should have a short between pins C, E and F. (refer to J1 designators on instrument PCB for probe pin definition.) Rectal probes should have a short between pins C and E but open between pins F and C or E.
	Bad probe.	Replace probe.
Probe: Plugged in but no display	Probe not characterized	A new probe must be installed and left in the storage channel until the display goes blank. If probe is extracted during characterization, display goes blank and operation is halted.

Troubleshooting Table (continued)

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
Normal/ Monitor Mode switching problems	Ambient above 33.9°C (93.0°F)	Causes auto switch to Monitor mode.
	Switched to Monitor mode before probe in mouth.	If 30 seconds pass after ready in Normal mode, unit switches to Monitor mode. If probe is still cooling from a previous temperature and used immediately, it might sense ambient to be above 33.9°C (93.0°F).
	Defective switch	Check J3A-10 for proper Mode switch function.
		Check U1-30 for proper switch function.
	Insufficient Mode button depression time	Press and hold the Mode button for at least 2 seconds.
Cannot enter Biotech Mode	No probe installed	A probe must be plugged into the instrument with its shaft fully inserted into the probe holder.
	Failed component, broken trace.	Check proper switch operation. Refer to F/C, Mode, and Recall switch troubleshooting.
Cal Key doesn't activate thermometer	Probe switch not activated.	Model 767 Thermometers need the probe switch activated before they will start. Place a probe shaft in the storage channel, then remove it to start Cal Key measurement.
Cal Key shows OrL, rEC, or ALy	Defective Cal Key	Replace Cal Key

Troubleshooting Table (continued)

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
Cal Key shows only "°F".	Defective mode switch or broken trace.	Check proper switch operation. Refer to F/C, Mode, and Recall Switch troubleshooting section, above.
Monitor mode temperature reading too low.	Probe malfunction	Change probe. Test calibration of entire system (instrument and probe) with the M9600 Calibration Tester.
	Instrument malfunction.	Check calibration with Cal Key.
	Improper placement of probe.	Probe must be under the tongue and as far back as possible into the sublingual pocket.
	Temperature not stable.	Allow three minutes for Monitor mode reading to stabilize in mouth.
Monitor mode temperature reading too high	Probe malfunction	Change probe or test calibration of entire system (instrument and probe) with the M9600 Calibration Tester.
	Instrument malfunction.	Check calibration with Cal Key.
Normal mode temperature reading too low.	Probe malfunction.	Recharacterize probe. (remove completely from instrument and re-install.) Or change probe. Or test calibration of entire system using 9600.

Troubleshooting Table (continued)

SYMPTOM	POSSIBLE CAUSE	PROCEDURE
Normal mode temperature reading too low (continued)	Instrument malfunction	Check calibration with Cal Key.
	Improper placement of probe.	Probe must be under the tongue and as far back as possible into the sublingual pocket.
Normal mode temperature reading too high.	Probe malfunction.	Recharacterize probe. (remove completely from instrument and re-install.) Or change probe. Or test calibration of entire system using 9600.
	Instrument malfunction	Check calibration with Cal Key.
	Improper technique.	Movement in mouth after insertion and before final temperature is displayed can cause high readings. Place probe quickly into sublingual pocket and hold still.
	Improper technique.	Do not place probe in mouth until display is showing “OrL”.

FIELD SERVICEABLE REPAIRS

Repairs are considered field serviceable if the repair will not alter the calibration or proper operation of the instrument. Recalibration requires a computer-based system and is normally performed at the factory.

All probes designed to work with the thermometer are fully interchangeable.

All components in the Model 767 Thermometer can be replaced without effecting instrument operation or calibration. Some minor changes to the exact calibration point will be caused by changing R20, R21 and R23, but as long as the proper type and tolerance resistors are used (0.1%, supplied by Welch Allyn), the unit will remain within specifications.

FIELD SERVICEABLE PARTS

All parts are serviceable by qualified technicians except for the EEPROM and the Monochip

THERMOMETER DISASSEMBLY

Please note that if your thermometer is within the warranty period, you should return the unit to an authorized service representative for servicing; failure to do so will invalidate the warranty.

WARNING: This instrument contains microelectronic devices which are highly susceptible to damage by static discharge. Use proper handling and grounding techniques while working on the internal electronics.

1. Remove the power supply/power from the unit.
2. Withdraw the probe from the probe storage channel.
3. Unplug the probe connector from the thermometer.
4. Lay the thermometer on its Front and Temperature housings (front surface).
5. Remove the six Torx screws from the rear housing.
6. Carefully lay the thermometer on its Rear housing, making sure that the Front and Temperature housings do not separate from the Rear housing.
7. Remove the Front and Temperature housings from the Rear housing.

Note: The Front and Temperature housings cannot be completely removed from the Rear housing unless the Main PCA (and horn)or Display PCA are unscrewed from their housings.

8. Unplug the probe cable (P1) from its header (J1).
9. Unplug the probe switch cable from its header (S2).
10. Remove the Main PCA by unscrewing the 3 Phillips screws holding the PCA to the Rear housing. Then gently lift the PCA upward while prying the horn loose from the Rear housing. Note the horn location for reassembly.

Caution: Use care when removing the horn. Excessive force on the horn wires can break them, and excessive upward force on the horn can break it.

11. Remove the Display PCA by unscrewing the 8 Torx screws then gently lifting the Display PCA out of the Front housing. Often, the zebra strips and LCD lift out with the Display PCA. Only cohesion holds them together, so take care that the LCD does not drop and break.

Caution: While lifting the LCD out of the Front housing, do not allow it to slide along or drop on the plastic window. This would leave visible scratches and should then be replaced.

FIGURE 4 - THERMOMETER ASSEMBLY DRAWING

Item	Part Number	Description	Qty
1	20983-1000	PCA, TEMP/DISP/CONN	1
2	25211-0000	HOUSING, FRONT	1
3	25212-0000	HOUSING, REAR	1
4	25213-0000	HOUSING	1
5	25214-0000	WINDOW, LCD	1
6	25215-0000	PLUG, BP	1
7	25219-0000	HOLDER, PROBE	1
8	43012-0000	BEAD, FERRITE	1
9	58101-000	SWITCH, PROBE	1
10	58102-000	HORN, PIEZO	1
11	58518-0000	CONNECTOR, ZEBRA	2
12	58522-0000	CAP, MODE SWITCH	1
13	60023-0000	LCD, TEMPERTURE	1
15	70827-0000	LABEL, MODEL 767T	1
16	80122-0000	CABLE, 6 CONDUCTOR	21
17	80123-0000	CABLE, 3 CONDUCTOR	1.
18	81054-0000	WASHER, FIBER .187 OD X .089 ID .031 THK	2
19	83047-0000	SCREW, MACH 6-32 X 1/4 P-PL-S-Z	3
20	83140-0000	SCREW, MACHINE, 6-32 X 1/4 SEMS, INT TOOTH P-PL-S-Z	6
21	83166-0000	SCREW, PLASTITE #2-28 X 1/2 LONG TORX, PAN HEAD	6
22	83167-0000	SCREW, PLASTITE #2-28 X 1/4 LONG TORX, PAN HEAD	12
23	83169-0000	SCREW, 2-56 X 3/8 SEMS, INTERNAL, P-PL-S-Z	2
24	85254-0000	PLATE, ATTACHMENT	1
25	85255-0000	BRACKET, PROBE	1
26	95128-0000	TAPE, DOUBLE-SIDED WHITE, .005 X .5	.13 FT
27	95129-0000	TAPE, DRAFTING 1 IN WIDE	.25 FT

FIGURE 2 - THERMOMETER ASSEMBLY DRAWING (CONTINUED)

FIGURE 5 - SYSTEM SCHEMATIC

FIGURE 6 - PRINTED CIRCUIT ASSEMBLY

THERMOMETER REASSEMBLY

1. If the Display PCA has been removed from the Front housing, lay the Front housing on a flat surface. Ensure that the LCD and zebra strips have been installed into the Front housing (the bump on one end of the LCD should be to the right as you look in the back of the Front housing). Then, carefully install the Display PCA into the Front housing, with the display flex-strip (J2) on the left side. Install the eight Torx display retaining screws, starting with the upper right side and continuing counterclockwise.

2. If the Main PCA has been removed from the Rear housing, lay the Rear housing on a flat surface and place the Front and Temperature housings (with the Main PCA attached by the flex-strip) immediately to the right. Then reinstall the horn to the Rear housing using the same double-stick tape.

Note: If the double-stick tape was destroyed upon horn removal, replace it with the same type of tape.

Note: Reinstall the horn in the same position from where it was removed.

Install the Main PCA into the Rear housing, with its three mounting holes aligned with the three standoffs. Then install and tighten the 3 Phillips retaining screws.

3. Plug the probe switch cable into the probe switch header (S2).

4. Plug the probe cable connector (P1) into the probe cable header (J1).

5. Position the display and Temperature housings onto the Rear housing. Ensure that the Mode button cover and BP plug have been installed.

6. Carefully lay the instrument on its Front and Temperature housings and install the six Torx screws.

7. Connect the Model 767 Thermometer to its power supply.

8. Plug the probe connector into the probe connector receptacle.

9. Insert the probe's shaft into the storage channel.

10. Turn on power and check for the proper power-up sequence.

SUGGESTED SPARE PARTS LIST

PART NO.	DESCRIPTION	QTY PER 100 UNITS
20991-0000	ASSY, CONNECTOR PCA WITH CABLE & FERRITE BEAD	5
20992-0000	ASSY, PROBE SWITCH	5
58102-000	HORN, PIEZO	4
81054-0000	WASHER, FIBER .187 OD X .089 ID .031 THK	8
83166-0000	SCREW, PLASTITE #2-28 X 1/2 LONG TORX, PAN HEAD	12
83167-0000	SCREW, PLASTITE #2-28 X 1/4 LONG TORX, PAN HEAD	12
95128-0000	TAPE, DOUBLE-SIDED WHITE, .005 X .5	A/R

OPTIONS AND ACCESSORIES

- Rectal Probe
- Second Probe Holder
- Backlight
- Probe covers
- Calibration Tester
- Calibration Key for verifying calibration - inserts in place of probe plug and provides correct reading of 97.3°F.

Welch Allyn

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